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Applicant: HIROSHI SAKAMOTO ET AL.

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Filed: SEPTEMBER 1, 2000 Examiner: BRYAN FISCHMANN

Title: POWER TRANSMISSION APPARATUS OF MOTOR VEHICLES

REQUEST TO PLACE REFERENCES IN THE FILE

Commissioner for Patents
Washington, D.C. 20231

Sir:

Please place the attached references in the file wrapper for the above-identified application. These references, although not believed to be relevant to the allowed subject matter, were cited to the Applicant in a corresponding European Search Report.

Respectfully submitted,

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Abstract of FR 2 699 127

A device for changing the operation mode of a thermal-electric dual-mode vehicle, and dual mode vehicle comprising such a device

A device for changing the operation mode of a thermal-electric dual mode vehicle comprising a thermal motor (10), an electric motor (20) and a gear box (30) comprising a primary gear train (31) and a secondary gear train (32).

According to the invention, said device comprises a disengageable coupling member (50) between the thermal motor (10) and the primary gear train (31) of the gear box (30) and a disengageable connection between the electric motor (20) and a power take-off (33) on said primary gear train (31).

Applicable in particular to refuse collectors.

Abstract of FR 2 777 231

Support method for a low speed of the thermal motor of a hybrid vehicle

The invention relates to a method for controlling a motor vehicle with parallel hybrid motorisation, comprising a transmission (12) which is permanently coupled to an electric motor (18) and to a thermal motor (14) by means of a clutch (16), the transmission (12) supplying a motor torque to the wheels (20), and of the type comprising an electronic module (30) which, as a function of the position of an accelerator (34), controls the thermal motor (14) and the electric motor (18) and the clutch (16), characterized in that, starting from an initial state in which the thermal motor (14) is running and the clutch (16) is disengaged, the electronic module (30) implements an assistance mode at low speed, in particular at start-up, according to which the thermal motor (14) and the electric motor (18) supply, at least during a first phase, thermal (C_{MT}) and electric torques (C_{ME}) respectively, as a function of a distributio (α) stemming from a predefined control law, and according to which the clutch (16) is controlled to be engaged.

Translation of German laid-open print 195 28 628

Description

According to the preamble of claim 1 the invention relates to a hybrid drive for a motor vehicle comprising as drives a primary drive source, in particular an internal combustion engine, and an electric motor.

Such a hybrid drive is shown in DE 44 36 383 A1, for example. Here, the electric motor takes effect via the drive shaft of the variable-speed transmission, in this case a manual transmission, as both a battery-operated driving engine, in particular within the low speed range, and a generator. During the generator operation, energy can be regenerated e.g. in phases of overrun condition and/or braking condition, and the vehicle can also be decelerated.

It is the object of the invention to further develop the generic hybrid drive so as to ensure comfortable and safe driving conditions with optimum energy regeneration.

This object is achieved according to the invention by the characterizing features of claim 1. Advantageous further developments of the invention follow from the other claims.

The invention proposes that the regenerative braking effect of the electric motor be controlled as a function of the deceleration of the vehicle so as to enable jerk-free deceleration runs with high energy regeneration. Such deceleration runs may proceed e.g. in a characteristic diagram-controlled fashion according to defined deceleration algorithms.

In a simplified embodiment, the regenerative braking effect

ratio, the regenerative braking effect and/or the generator output of the electric motor being relatively little when the transmission ratio is low and relatively great when the transmission ratio is high. In this case, the optionally given transmission ratios of the variable-speed transmission can be linked with the controllable regenerative braking effect such that an at least approximately equal vehicle deceleration is obtained in all of the transmission ratios.

In the case of vehicles having an antiskid device or an anti-block system in the driving brake, the slip sensors available on the driving wheels may also contribute to the control of the regenerative braking effect of the electric motor. This means that with a defined wheel slip occurring at the driven wheels and an actuated or non-actuated brake of the motor vehicle the generator effect of the electric motor is correspondingly reduced or optionally even deactivated. This is to ensure that e.g. in the case of road conditions having a low coefficient of adhesion unstable driving conditions are avoided. On the other hand, the generator output of the electric motor can be utilized with optimum effect within the comfort limits and the adhesion conditions defined by the road to regenerate energy.

An embodiment of the invention is explained in more detail below. In the drawing,

figure 1 shows a block diagram of a hybrid drive for a motor vehicle comprising a driving unit with an internal combustion engine and an electric motor and means for controlling the regenerative braking effect of the electric motor, and

figure 2 shows a diagram with the regenerative braking moment M_B of the electric motor at various transmission ratios.

The hybrid drive as shown is composed substantially of an internal combustion engine 10, an electro-hydraulic disconnect-type clutch 12, a variable-speed transmission 14 and an electric motor 16, which are divided into segments for the purpose of better presentation but are actually assembled to form a driving unit.

The internal combustion engine 10 may be a direct injection turbodiesel engine, for example, whose disk flywheel 18 flanged to the crankshaft forms part of the disconnect-type clutch 12 designed as a momentum-utilizing automatic with a hydraulic actuation - comprising a hydraulic slave cylinder 20 and a hydraulic unit 22 having a pump, control valves, pressure accumulator, etc. - and a control electronics 24.

The disconnect-type clutch 12 drives the front end of the drive shaft 26 of the variable-speed transmission 14 whose output shaft 28 carries a drive pinion 30 for the axle drive which is not shown in more detail and/or the differential 32 for the drive of the front wheels 34 of the motor vehicle. As can be seen, four gear steps or transmission ratios I-IV of the variable-speed transmission 14 of the embodiment can be shifted via a shift control device which is not shown.

The electric motor 16, i.e. a three-phase synchronous motor having a relatively low moment of inertia acts via a gearwheel intermediate transmission step 36 without an intermediate clutch directly on the other end of the drive shaft 26 of the variable-speed transmission 14.

The electric motor 16 is connected to a power supply unit 38 having batteries 40 and a current control unit 42 and can be used as a driving engine, as a generator for charging the batteries 40 when the internal combustion engine is operated, in the neutral position and finally as a synchronizer for the variable-speed transmission 14.

The electric motor 16 may in this case be switched by means of an operating mode switch 44 to electric drive, its driving output then being controlled via gas pedal 46 and the current control unit 42.

When the internal combustion engine 10 is operated, the electric motor 16 is run as a generator if the batteries 40 are to be regenerated; failing this, the electric motor 16 is operated in the neutral position or also drives the motor vehicle to shortly increase the driving output of the hybrid drive.

As soon as the shift control device (not shown) of the variable-speed transmission 14 introduces a shift change i - this is detected by the control electronics 24 of the separation clutch 12 using electric switches and/or potentiometers integrated into the shift control device -, the disconnect-type clutch 12 is disengaged and the electric motor 16 is simultaneously activated as a synchronizer. In this case, a control electronics in the current control unit 42 calculates the necessary nominal speed of the drive shaft 26 by means of speed signals n of the output shaft 26 and of gear signals i of the gear to be shifted of the variable-speed transmission 14, compares them with the actual speed signal and controls via the current control unit 42 a positive or negative acceleration of the electric motor 16 to obtain a synchronous run of the transmission ratio to be changed.

If the electric motor of the hybrid vehicle is operated in a way set in advance by the operating mode switch 44 and also if the internal combustion engine is operated, the control electronics (not shown) of the current control unit 42 will control the regenerative braking effect exerted by the electric motor 16 during the generator operation or when the batteries 40 are charged again.

This regenerative braking effect corresponds to a defined

introduced transmission ratio I to IV of the variable-speed transmission 14 in connection with the controlled generator output (in the case of an overrun condition without braking by the driving brake).

In this connection, figure 2 shows braking moment curves or generator output curves corresponding to transmission gears I-III, the braking moment M_B each multiplied with the transmission i resulting in an approximately equal vehicle deceleration. For example, curve I shows a slight increase in the generator output of the electric motor 16 with a correspondingly low final output which, however, when compared with the correspondingly high driving torque results in a high regenerative braking effect while e.g. the torque curve M_B in the third gear III shows a steep increase in torque and a high final braking moment, which, however, when compared with the lower driving torque transmission ratio corresponds to about the same vehicle deceleration a_B.

The control electronics of the current control unit 42 is also connected to the control unit 48 of an anti-block brake system of the driving brake of the motor vehicle. By means of this control unit the wheel slip is checked using wheel slip sensors (not shown) on the front wheels 34 of the motor vehicle. The actuation of the driving brake is also detected by brake signal B.

In the case of an inadmissible wheel slip occurring in the case of a detected overrun condition and optionally a braking operation by the driving brake, the control electronics in the current control unit 42 is driven by the ABS control unit 48 and the regenerative braking effect of the electric motor 16 is reduced or optionally deactivated. This can be done e.g. by lowering the control curves, shown in figure 2, of the motor brake moment M_B down to a control curve thereunder or in the case of the control curve in accordance with the first gear by deactivating the

dimensional characteristic diagram filed in the control program of the control electronics.

The following conditions are useful for controlling the regenerative braking effect:

normal overrun condition (e.g. freewheeling in front of a red traffic light)	-	no regenerative braking effect
decelerating overrun condition detected by quick release of the gas pedal, by a downhill sensor, speed control, etc.	-	regenerative braking effect depending on transmission and optionally also on wheel slip
overrun condition plus braking actuation	-	regenerative braking effect depends on transmission and wheel slip

Claims

1. A hybrid drive for a motor vehicle having an internal combustion engine and an electric motor as drives acting on the drive shaft of a variable-speed transmission of the motor vehicle, the electric motor being reversible as a generator to produce a regenerative braking effect in the overrun or braking condition, characterized in that the regenerative braking effect of the electric motor (16) is directly or indirectly controlled as a function of the vehicle deceleration.

2. The hybrid drive according to claim 1, characterized in that the regenerative braking effect of the electric motor (16) depends on the transmission ratio.

3. The hybrid drive according to claims 1 and 2, characterized in that the regenerative braking effect of the electric motor (16) is relatively little in the case of a low transmission ratio and relatively great in the case of a high transmission ratio.

4. The hybrid drive according to claims 1 to 3, characterized in that the ratio of regenerative braking effect to transmission ratio is controlled such that the substantially equal vehicle deceleration will always result.

5. The hybrid drive according to claims 1 to 4, characterized in that the regenerative braking effect is additionally controlled as a function of the wheel slip of the driven wheels (34) and is reduced or deactivated when wheel slip occurs.

6. The hybrid drive according to claim 5, characterized in that the control unit (48) of vehicles having ABS brake control communicates with the control electronics of the current control unit (42) of the electric motor (16) and influences the regenerative braking effect during the control operation.